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Applicant:	Kazuyuki Kabe
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For:	PNEUMATIC TIRE WITH BELT LAYER INCLUDING A PLURALITY OF STRIP PIECES AND METHOD OF MANUFACTURING THE SAME (as amended)
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Examiner:	Johnstone, Adrienne C.

CERTIFIED TRANSLATION OF PRIORITY APPLICATION

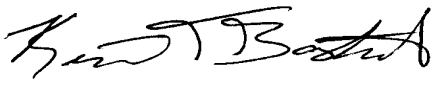
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Attached is a certified translation of Japanese Application No. 22003-429318. This translation is being submitted to perfect applicant's priority date of December 25, 2003, which is respectfully requested.

Respectfully submitted,

GREER, BURNS & CRAIN, LTD.

By 

Kevin T. Bastuba
Registration No. 59,905

February 2, 2010
300 South Wacker Drive
Suite 2500
Chicago, Illinois 60606
(312) 360-0080
Customer No. 24978

VERIFICATION OF TRANSLATION

I, the below named translator, hereby declare that:

My name and address are as stated below;

That I am knowledgeable in the English language and the Japanese language and that I believe the hereto attached English translation is an accurate translation of Japanese patent application No. 2003-429318 filed December 25, 2003.

I hereby declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: December 29, 2009

Full name of the translator: Norio TANABE

Signature of the translator: Norio Tanabe

Post Office Address: c/o SEIRYU International Patent Office,
37 KOWA Building, 4-5 Tsukiji 1-chome,
Chuo-ku,Tokyo 104-0045 JAPAN

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[Inventor]

[Address or Residence] c/o The Yokohama Rubber Co., Ltd., Hiratsuka Factory, 2-1, Oiwake, Hiratsuka-shi, Kanagawa-ken

[Name] Kazuyuki KABE

[Inventor]

[Address or Residence] c/o The Yokohama Rubber Co., Ltd., Hiratsuka Factory, 2-1, Oiwake, Hiratsuka-shi, Kanagawa-ken

[Name] Tsuneo MORIKAWA

[Applicant]

[Identification Number] 000006714

[Personal or Firm Name] THE YOKOHAMA RUBBER CO., LTD.

[Agents]

[Identification Number] 100066865

[Patent Attorney]

[Personal or Firm Name] Shin-ichi OGAWA

[Elected Agent]

[Identification Number] 100066854

[Patent Attorney]

[Personal or Firm Name] Kensho NOGUCHI

[Elected Agent]

[Identification Number] 100068685

[Patent Attorney]

[Personal or Firm Name] Kazuhiko SAIKA

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[List of Matters Submitted]

[Matter] CLAIMS 1

[Matter] SPECIFICATION 1

[Matter] DRAWINGS 1

[Matter] ABSTRACT 1

[Document] CLAIMS

[Claim 1]

A pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, wherein assuming that respective strip pieces have a width A, the strip pieces being in a number N, and the belt layer having a cord angle θ relative to a circumferential direction of the tire and a circumferential length L, an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected for N and the belt layer is formed by arranging N strip pieces equidistantly interspaced in the circumferential direction of the tire.

[Claim 2]

A pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, wherein providing that respective strip pieces have a width A and a thickness G, respective belt layers have a cord angle θ relative to a circumferential direction of the tire, and that belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2, while an integer satisfying $L_1 = N_1 \times A/\sin\theta$ is selected for the number N_1 of strip pieces, the number N_2 of strip pieces is set to be equal to N_1, and the inner belt layer is provided by joining the N_1 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces, while the outer belt layer is provided by arranging the N_2 strip pieces with a spacing of $2\pi G/N_2$ in the circumferential direction of the tire, on the inner belt layer.

[Claim 3]

A method of manufacturing a pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn

altogether and rubberized, which comprises forming the belt layer by arranging N strip pieces equidistantly interspaced in a circumferential direction of the tire on a forming drum, wherein for the number N of strip pieces an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected, in which A is a width of respective strip pieces, θ being a cord angle of the belt layer relative to the circumferential direction of the tire and L being a circumferential length of the belt layer.

[Claim 4]

A method of manufacturing a pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, which comprises: providing that respective strip pieces have a width A and a thickness G, that respective belt layers have a cord angle θ relative to a circumferential direction of the tire, that belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2, that an integer satisfying $L_1 = N_1 \times A/\sin\theta$ is selected for the number N_1 of strip pieces, and that the number N_2 of strip pieces is set to be equal to N_1; forming the inner belt layer by joining the N_1 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces, while the outer belt layer is provided by arranging the N_2 strip pieces with a spacing of $2\pi G/N_2$ on the inner belt layer.

[Claim 5]

A pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, wherein providing that A is a width of respective strip pieces, N being a number of strip pieces, θ being a cord angle of the belt layer relative to a circumferential direction of the tire, and L being a circumferential length of the belt layer; the belt layer is formed by

providing an annular body by joining N strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces and stretching the annular body to the circumferential length L, wherein for the number N of strip pieces, an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected.

[Claim 6]

A pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, wherein providing that respective strip pieces have a width A, respective belt layers have a cord angle θ relative to a circumferential direction of the tire, and belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2, and while an integer satisfying $L_2 = N_2 \times A/\sin\theta$ is selected for the number N_2 of strip pieces, the number N_1 of strip pieces satisfies $N_1 = N_2 - 1$; the inner belt layer is formed by providing an annular body by joining N_1 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces and stretching the annular body to the circumferential length L_1, while the outer belt layer is formed by joining N_2 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces, on the inner belt layer.

[Claim 7]

A method of manufacturing a pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, which comprises forming the belt layer by providing an annular body by joining N strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces on a diametrally expandable or contractible forming drum and stretching the annular body to a circumferential length L

L by diametrally expanding the forming drum, wherein for the number N of strip pieces an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected, in which A is a width of respective strip pieces, θ being a cord angle of the belt layer relative to a circumferential direction of the tire and L being a circumferential length of the belt layer. [Claim 8]

A method of manufacturing a pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, which comprises: providing that respective strip pieces have a width A, that respective belt layers have a cord angle θ relative to a circumferential direction of the tire, that belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2, and that while an integer satisfying $L_2 = N_2 \times A/\sin\theta$ is selected for the number N_2 of strip pieces, the number N_1 is set to satisfy $N_1 = N_2 - 1$; forming the inner belt layer by providing an annular body by joining N_1 strip pieces with the sides of each strip piece butted against sides of its neighboring strip piece on a diametrally expandable or contractible forming drum and thereafter stretching the annular body to the circumferential length L by diametrally expanding the forming drum, and thereafter forming the outer belt layer by joining N_2 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip piece on the inner belt layer.

[Document] SPECIFICATION

[Title of the Invention] PNEUMATIC TIRE AND METHOD OF MANUFACTURE THEREOF

[Art Field]

[0001]

The present invention relates to a pneumatic tire provided with a belt layer comprising a plurality of strip pieces and a method of manufacture thereof, and more specifically, a pneumatic tire and a method of manufacture thereof according to which with use of a plurality of strip pieces a belt layer can be formed with no mutual overlapping of the strip pieces.

[Background Art]

[0002]

Generally, the belt material from which a belt layer of a pneumatic tire is formed is provided by bias-cutting a calendered material comprising a plurality of steel cords drawn altogether and rubberized and then splicing the cut material pieces together or altogether in a manner such that the cut ends of the cut material pieces form side edges of the belt material. On the other hand, belt layers of pneumatic tires have different belt widths and cord angles depending on various tire specifications. Accordingly, it is necessary to there have a variety of belt material different in the dimensional specification provided preparatively for various tire specifications.

[0003]

In consequence, in the case of conventional tire manufacturing installations, the need arises for a broad space for storing a wide variety of belt material in stock. Also, now that a belt material processed in accordance with a particular tire specification cannot be made an applied use of for a belt material for another tire

specification, there lies the problem that a surplus of a belt material tends to occur in tire manufacturing steps, when not only the material is wasted but also a degradation of product quality is likely in that cords are prone to be exposed when the belt material is cut along the cords. Moreover, in carrying out manufacture of a wide variety of tires each in a small quantity, it is required each time when the tire specification is altered to exchange drums each having a belt material of a large length taken up thereon, and another problem is posed that the productivity cannot be high.

[0004]

To give solution to the above problems, it has been proposed to provide a belt layer having a dimensional specification as desired by splicing a large number of strip pieces each comprising a plurality of steel cords altogether drawn and rubberized in a manner such that while the strip pieces are arranged at an inclination relative to a circumferential direction of a tire to be produced, they are butted against one another with their side end edges (see e.g. patent-related documents 1 and 2 below), According to this proposition, the inconveniences attributable to belt material each of a large length for respective tire specifications can be cancelled.

[0005]

In constituting a belt layer in or of a pneumatic tire by a large number of strip pieces as above, however, it is desirable that the strip pieces are constant in width and, in addition, the belt layer has a cord angle which is predetermined, so that it is difficult to have an integer number of strip pieces butt-joined over the entire circumference of a tire: In greater detail, when strip pieces are aligned in the circumferential direction of a tire, a mutual overlapping of strip pieces will be produced unless in a part of the belt layer in the circumferential direction of the tire a possible surplus portion of a strip piece is cut away. Also, even if the but-joining of strip pieces over the entire

circumference of the tire is attained by incidence in the case of an optional belt layer, another belt layer may have a circumferential length different from that of the above optional belt layer, when a mutual overlapping of strip pieces will be produced in a part of the circumferential direction. Such mutual overlapping of strip pieces can be a factor to deteriorate the uniformity of tires. Then, if it is done to cut away any surplus portion of a strip piece in order to secure a butt-splicing, cords become exposed when the strip piece is cut along the cords, when deterioration of product quality is pone to take place.

[patent-related document 1] patent publication No. 53-11723.

[patent-related document 2] patent application Kokai publication No. HEI 11-99564.

[Disclosure of the Invention]

[Subject for Intended Solution by the Invention]

[0006]

The object of the present invention is to provide a pneumatic tire and a method of manufacture thereof according to which with use of a plurality of strip pieces a belt layer can be formed with no mutual overlapping of the strip pieces.

[Means for Solving the Subject]

[0007]

The method of manufacture of a pneumatic tire for attaining the above object according to the present invention is characterized in that, in a method of manufacturing a pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, the belt layer is formed by arranging a number N of strip pieces equidistantly interspaced in a circumferential direction of the tire on a forming drum, wherein for the number N of

strip pieces, an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected, in which A is a width of respective strip pieces, θ being a cord angle of the belt layer relative to a circumferential direction of the tire and L being a circumferential length of the belt layer, namely a full length of the belt layer in the circumferential direction of the tire.

[0008]

The pneumatic tire according to the present invention, manufactured by the above method, is characterized in that, in a pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, the belt layer is formed by arranging a number N of strip pieces equidistantly interspaced in a circumferential direction of the tire, wherein an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected for the number N of strip pieces, in which A is a width of respective strip pieces, θ being a cord angle of the belt layer relative to the circumferential direction of the tire, and L being a circumferential length of the belt layer.

[0009]

Also, the method of manufacturing a pneumatic tire for attaining the above object according to the present invention is characterized that, in a method of manufacturing a pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, providing that respective strip pieces have a width A and a thickness G, that respective belt layers have a cord angle θ relative to a circumferential direction of the tire, and that belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2; while an integer satisfying $L_1 = N_1 \times A/\sin\theta$ is selected for the number N_1 of strip pieces, the number N_2 of strip pieces is set to be equal to N_1, and

the inner belt layer is formed by joining N_1 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces, while the outer belt layer is provided by arranging N_2 strip pieces with a spacing of $2\pi G/N_2$ on the inner belt layer.

[0010]

The pneumatic tire according to the present invention, manufactured by the above method, is characterized in that, in a pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, providing that respective strip pieces have a width A and a thickness G, that respective belt layers have a cord angle θ relative to a circumferential direction of the tire, that belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2; while an integer satisfying $L_1 = N_1 \times A/\sin\theta$ is selected for the number N_1 of strip pieces, the number N_2 of strip pieces is set to be equal to N_1, and the inner belt layer is provided by joining N_1 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces, while the outer belt layer is provided by arranging N_2 strip pieces with a spacing of $2\pi G/N_2$ in the circumferential direction of the tire, on the inner belt layer.

[0011]

Further, the method of manufacturing a pneumatic tire for attaining the above object according to the present invention is characterized in that, in a method of manufacturing a pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, the belt layer is formed by providing an annular body by joining a number N of strip pieces to one another with sides of each strip piece butted against sides of its neighboring

strip pieces on a diametrally expandable or contractible forming drum and then stretching the annular body to a circumferential length L by diametrally expanding the forming drum, wherein for the number N of strip pieces, an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected, in which A is a width of respective strip pieces, θ being a cord angle of the belt layer relative to the circumferential direction of the tire and L being a circumferential length of the belt layer.

[0012]

The pneumatic tire according to the present invention, manufactured by the above method, is characterized in that in a pneumatic tire provided with a belt layer formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, providing that respective strip pieces have a width A, strip pieces being in a number N, the belt layer having a cord angle θ relative to the circumferential direction of the tire, and the belt layer having a being a circumferential length L; the belt layer is formed by providing an annular body by joining N strip pieces to one another with sides of each strip piece butted against sides of its neighboring strips pieces and then stretching the annular body to the circumferential length L, wherein for the number N of strip pieces, an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected.

[0013]

Furthermore, the method of manufacturing a pneumatic tire for attaining the above object according to the present invention is characterized in that in a method of manufacturing a pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, providing that respective strip pieces have a width A, that respective belt layers have a cord angle θ relative to a circumferential direction of the tire, and that belt

layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2; while an integer satisfying $L_2 = N_2 \times A/\sin\theta$ is selected for the number N_2 of strip pieces, the number N_1 is set to satisfy $N_1 = N_2 - 1$, and the inner belt layer is formed by providing an annular body by joining N_1 strip pieces joined to one another with the side end edges of each strip piece butted against side end edges of its neighboring strip piece on a diametrally expandable or contractible forming drum and then stretching the annular body to the circumferential length L by diametrally expanding the forming drum, and thereafter the outer belt layer is formed by joining N_2 strip pieces one another with side end edges of each strip piece butted against side end edges of its neighboring strip piece on the inner belt layer.

[0014]

The pneumatic tire according to the present invention, manufactured by the above method, is characterized in that in a pneumatic tire provided with two belt layers each formed of a plurality of strip pieces each comprising a plurality of steel cords drawn altogether and rubberized, providing that respective strip pieces have a width A, respective belt layers have a cord angle θ relative to a circumferential direction of the tire, and belt layers comprise an inner belt layer and an outer belt layer formed by respective numbers N_1 and N_2 of strip pieces and having respective circumferential lengths L_1 and L_2, and that while an integer satisfying $L_2 = N_2 \times A/\sin\theta$ is selected for the number N_2 of strip pieces, the number N_1 of strip pieces satisfies $N_1 = N_2 - 1$; the inner belt layer is formed by providing an annular body by joining N_1 strip pieces to one another with sides of each strip piece butted against sides of its neighboring strip pieces and then stretching the annular body to the circumferential length L_1, while the outer belt layer is formed by joining N_2 strip pieces to one another with sides of each

lstrip piece butted against sides its neighboring strip pieces, on the inner belt layer.

[Effect/Result of the Invention]

[0015]

According to the present invention, the or each belt layer is formed by arranging an integer number of strip pieces to conform to a given circumferential length of the belt layer, so that the belt layer can be provided with use of an integer number of strip pieces, without producing a mutual overlapping of strip pieces. Also, the need is cancelled of cutting away a surplus portion of a strip piece along cords, so that a quality lowering likely when a cord is exposed can be avoided.

[0016]

According to the invention, it is possible to make the most of a merit from the forming of a belt layer from strip pieces: In greater detail, if the tire size is altered, it is possible to form a variety of belt layers with use of strip pieces of a same width corresponding to various tire sizes by selectively altering the angle of inclination, the length and the number of pieces, of the strip pieces. Thus, the need can be obviated for the space for a stock for every tire specification and the generation of cut wastes does not take place, and moreover, it becomes possible to carry out a production of a wide variety of products each in a limited quantity as a result of that an operation for a large-scale changeover of manufacturing steps can be done without.

[Best Mode of Carrying Out the Invention]

[0017]

Now, with reference to the appended drawings, a description in greater detail will be entered into the constitution of the present invention.

[0018]

Fig. 1 shows an example of pneumatic tires obtainable by the pneumatic-tire

manufacturing method according to the present invention, and Fig. 2 and Fig. 3 are views, showing belt layers extracted from the pneumatic tire of Fig. 1, in which 1 is a tread part, 2 being a sidewall and 3 being a bead portion.

[0019]

As shown in Fig. 1, between a pair of bead portions 3, 3, one on a left side and the other on a right side of the tire, a carcass layer 4 is mounted in a manner of bridging the bead portions. At its each end part, the carcass layer 4 is turned back around a bead core 5 buried in each bead portion 3, from an inner side to an outer side of the tire. Then, on the side of an outer periphery of the carcass layer 4 in the tread part 1, two belt layers B (B_1, B_2) each comprising a plurality of steel cords altogether drawn and rubberized are embedded in an arrangement of one placed on top of the other.

[0020]

As shown in Fig. 2 and Fig. 3, each belt layer B is composed of an integer number of strip pieces S each comprising a plurality of steel cords C which are altogether drawn and rubberized, which are arranged at an angle to a circumferential direction of the tire and joined altogether with side end edges of a strip piece S butting to a side end edge of its each neighboring strip piece S to a joined total length corresponding to one round length of the tire. In other words, strip pieces S are but-spliced for a full circumferential length of the tire. The two belt layers B, B are plied in a manner such that steel cords C in one layer crosses the steel cords C in the other.

[0021]

Then, an explanation will be given the designing of the belt layer in or of the pneumatic tire under reference. Fig. 4 is taken for an illustration of the designing of

the belt layer. Herein it is assumed that the strip pieces S have a width A, the number of strip pieces is N, the cord angle of the belt layer B relative to the circumferential direction of the tire is θ, and the circumferential length of the belt layer B is L. In forming the belt layer B, an integer number of strip pieces S are altogether joined one by one to attain a joined total length corresponding to one round of the tire in a manner such that while the strip pieces are arranged at an inclination to the circumferential direction indicated at T of the tire, each strip piece S is butted with its side end edges against side end edges of its neighboring strip pieces, when assuming a length component of each strip piece S in the circumferential direction T is a, there is established a relationship of a = A/sin θ. Also, now that the number of the strip pieces S is N, L = N x a. The above equations may be rearranged to obtain the following equation (1):

$$\theta = \sin^{-1}(N \times A/L) \quad \ldots\ldots (1).$$

[0022]

That is to say, to have an integer number of strip pieces S butt-joined over a full circumference of the tire, it is required that the cord angle θ of the belt layer B satisfies the above equation (1). Herein, in case a basic design value α of the cord angle of the belt layer B relative to the circumferential direction T does not agree with the cord angle θ required for the butt-joining of strip pieces S, it is necessary to finely adjust the angle of inclination of the strip pieces S relative to the circumferential direction T based on the basic design value α and let the relationship of the above equation (1) be satisfied.

[0023]

It is provided, however, that preferably the difference between the basic design value α and the cord angle θ is not larger than 0.5°. If this difference exceeds

0.5°, the beforehand designed performance characteristics of the pneumatic tire will become adversely affected. Although the difference between the basic design value α and the cord angle θ clearly appears in Fig. 4, this is because the angular difference is depicted in exaggeration in Fig. 4 in order to facilitate understanding of the relation between the cord angle and the basic design value.

[0024]

In the case of the pneumatic tire provided with two belt layers B, B, the belt layers B, B have different circumferential lengths L on account of a thickness G of the strip pieces S. Therefore, according to the described procedures, it is difficult that while the belt layer B is formed with use of an integer number of strip pieces S without generating a mutual overlapping of strip pieces S, the cord angles θ of two belt layers B, B are brought to agree with each other. Accordingly, pursuant to the present invention, the following manufacturing method is carried out in forming belt layers with use of an integer number of strip pieces S without generating mutual overlapping of the strip pieces.

[0025]

Fig. 5 and Fig. 6 are taken for illustration of a first method of manufacture of the pneumatic tire according to the present invention. In greater detail, assuming that the width of strip pieces S is A, the number of strip pieces S is N, and the cord angle of belt layers B relative to circumferential direction of the tire is θ, an integer which satisfies $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selected out as the number N of the strip pieces, and N strip pieces are equidistantly arranged in the circumferential direction of the tire on a forming drum D as shown in Fig. 5 and Fig. 6 to form the belt layer B as shown in Fig. 5 and Fig. 6.

[0026]

In the above case, strip pieces S are arranged with a finely small gap corresponding to the difference between the circumferential length L and N x A/sin θ interposed between each adjacent strip pieces S. As a result of the above, it is possible to form a belt layer B with use of an integer number of strip pieces S, without an overlapping generated between adjacent strip pieces S.

[0027]

Fig. 7 and Fig. 8 are views, taken for illustration of a second method of manufacture of the pneumatic tire according to the present invention. This second one is a further specified method of the described first method: Assuming that the width of strip pieces S is A, the thickness of the strip pieces is G, the cord angle of each of belt layers B_1 and B_2 relative to the circumferential direction of the tire is θ, the numbers of strip pieces S forming inner belt layer B_1 and outer belt layer B_2 are N_1 and N_2 respectively, and the circumferential lengths of the inner belt layer B_1 and the outer belt layer B_2 are L_1 and L_2 respectively, for the number N_1 of strip pieces S an integer satisfying $L_1 = N_1 \times A/\sin\theta$ is selected while the number N_2 of strip pieces S is set to be equal to the number N_1, and as shown in Fig. 7 and Fig. 8, the inner belt layer B_1 is formed on a forming drum D by splicing N_1 strip pieces S one to the other with side end edges of a strip piece S butted against side end edges of its neighboring strip pieces S, and then the outer belt layer B_2 is formed by arranging N_2 strip pieces S on the inner belt layer B_1 with a gap of $2\pi G/N_2$ interposed between each adjacent strip pieces S.

[0028]

In the above case, in the outer belt layer B_2, N_2 strip pieces S are arranged with the finely a small interspace of $2\pi G/N_2$ between neighboring strip pieces S, whereby two belt layers B_1 and B_2 can be formed with use of an integer number of strip pieces S, without a mutual overlapping of strip pieces S. To add to

that, it is possible to let the inner belt layer B_1 and the outer belt layer B_2 have same cord angle θ.

[0029]

Fig. 9 and Fig. 10 are views, taken for illustration of a third method of manufacture of the pneumatic tire according to the present invention: Assuming that the width of strip pieces S to be A, the number of strip pieces S to be N, the cord angle of the belt layer B to the circumferential direction of the tire to be θ and the circumferential length of the belt layer B to be L, an integer satisfying $(N + 1) \times A/\sin \theta$ is taken as the number N of the strip pieces S, and as shown in Fig. 9 and Fig. 10, after an annular body is formed on a diametrally expansible or contractible forming drum D by splicing the N strip pieces S one to the other with side end edges of a strip piece S butted against side end edges of its neighboring strip pieces S, the forming drum D is diametrally expanded to stretch the annular body of strip pieces S to reach the circumferential length L, whereby the belt layer B is provided.

[0030]

In the above case, the N strip pieces S become arranged as being extended in the circumferential direction of the tire in a state of abutting to one another. As a result of this, a belt layer B can be formed with use of an integer number of strip pieces S, without a mutual overlapping of strip pieces S.

[0031]

Fig. 11 and Fig. 12 are views, taken for illustration of a fourth method of manufacture of the pneumatic tire according to the present invention. This fourth one is a further specified method of the third method. Assuming the width of strip pieces S to be A, the cord angle of each of belt layers B_1 and B_2 relative to the circumferential direction of the tire to be θ, the number of strip pieces S forming inner belt layer B_1 and

that forming outer belt layer B_2 to be N_1 and N_2 respectively, and the circumferential length of the inner belt layer B_1 and that of the outer belt layer B_2 to be L_1 and L_2 respectively, an integer satisfying $L_2 = N_2 \times A/\sin\theta$ is selectively taken for the number N_2 while the number N1 is set to satisfy $N_1 = N_2 - 1$, and as shown in Fig. 11 and Fig. 12, after an annular body is formed on a diametrally expandable or contractible forming drum D by splicing the N_1 strip pieces S one to the other with side end edges of a strip piece S butted against side end edges of its neighboring strip pieces S, the forming drum D is diametrally expanded to stretch the annular body of strip pieces S to reach the circumferential length L_1, whereby the inner belt layer B_1 is formed, and thereafter the outer belt layer B_2 is formed by splicing the N_2 strip pieces S one to the other with side end edges of a strip piece S butted against side end edges of its neighboring strip pieces S, on the inner belt layer B_1.

[0032]

In the above case, in the inner belt layer B_1, the N_1 strip pieces S become arranged as being extended in the circumferential direction of the tire in a state of abutting to one another. As a result of this, a belt layers B_1 and B_2 can be formed with use of an integer number of strip pieces S, without a mutual overlapping of strip pieces S. In addition, it is possible to let the inner belt layer B_1 and the outer belt layer B_2 have same cord angle θ.

[0033]

Now, an explanation will be given a calculation procedure in practical instances of manufacture of pneumatic tires. In Examples 1 and 2 below, the present invention was applied to pneumatic tires for passenger cars having as basic design values a cord angle of belt layers of 20° and maximum radius r of belt layers of 270 mm.

[0034]

Example 1:

In pneumatic tires for passenger car (175/65R14), it is commonly set that the width A of strip pieces is e.g. 2 πmm, the thickness G of each belt layer being 2 mm, the circumferential length L_1 of an inner belt layer being 2π x 268 mm, the circumferential length L_2 of an outer belt layer being 2π x 270 mm, a basic design value α_1 of cord angle of the inner belt layer being 20° and a basic design value α_2 of cord angle of the outer belt layer being 20°.

[0035]

Initially, the N_1 strip pieces S for constituting the inner belt layer will be obtained: $\alpha_1 = \sin^{-1} (N_1 \times A/L_1)$, hence $N_1 = 91.66$. Then, to meet the condition that N_1 is an integer, $N_1 = 91.66$ is rounded up to e.g. $N_1 = 92$. Thus, based on $\theta_1 = \sin^{-1} [(92 \times 2\pi)/(2\pi \times 268)]$, $\theta_1 \fallingdotseq 20.07°$. This cord angle θ_1 bears very small error with reference to the basic design value α_1.

[0036]

In connection with the outer belt layer, then, the N_2 strip pieces will be set to be equal to N_1, and the gap or interspace between neighboring strip pieces will be obtained based on $2\pi G/N_2$. In the present instance, the gap in reference is found to be 0.137 mm. Thus, the inner belt layer is formed on the forming drum based on the above found dimensional specification, and thereafter the outer belt layer is formed by arranging the N_2 strip pieces S with a spacing of 0.137 mm between neighboring strip pieces in the circumferential direction of the tire at a cord angle θ_2 same as the cord angle θ_1.

[0037]

As a result of the above, it becomes possible that in forming two belt layers

with use of strip pieces common to such belt layers, while the cord angle θ_1 of an inner belt layer and the cord angle θ_2 of an outer belt layer are set at a same angle ($\theta_1 = \theta_2$), the cord angle is approximated to a basic design value, namely without impairing tire characteristics as designed.

[0038]

Example 2:

In pneumatic tires for passenger car (175/65R14), it is commonly set that the width A of strip pieces is e.g. 2 πmm, the thickness G of each belt layer being 2 mm, the circumferential length L_1 of an inner belt layer being 2π x 268 mm, the circumferential length L_2 of an outer belt layer being 2π x 270 mm, a basic design value α_1 of cord angle of the inner belt layer being 20° and a basic design value α_2 of cord angle of the outer belt layer being 20°.

[0039]

Initially, the number N_2 of strip pieces S for constituting the outer belt layer will be obtained: $\alpha_2 = \sin^{-1} (N_2 \times A/L_2)$, hence $N_2 = 92.34$. Then, to meet the condition that N_2 is an integer, $N_2 = 92.34$ is rounded up to e.g. $N_2 = 93$. Thus, based on $\theta_2 = \sin^{-1} [(93 \times 2\pi)/(2\pi \times 270)]$, $\theta_2 \fallingdotseq 20.15°$. This cord angle θ_2 bears very small error with reference to the basic design value α_2.

[0040]

In connection with the inner belt layer, then, the number N_1 of strip pieces will be set to be equal to N_2. Then, while the cord angle θ_1 of the inner belt layer is set to be equal to θ_2, an annular body is formed by splicing the N_1 strip pieces S to one another with side end edges of a strip piece abutted against side end edges of its adjacent strip pieces on a diametrally expandable or contractible forming drum, and thereafter the annular body is expanded to the circumferential length L_1 by diametrally

expanding the forming drum to form the inner belt layer. Then, the outer belt layer is formed on the outer side of the inner belt layer based on the above found dimensional specification.

[0041]

As a result of the above, in forming two belt layers with use of strip pieces S common to the two belt layers, it is possible to butt-splice the strip pieces in each belt layer over a whole of the circumference of the tire while the cord angle θ_1 of the inner belt layer and that θ_2 of the outer belt layer are closely approximated to a basic design value.

[0042]

The above described Examples are by way of illustration only, and the present invention is not limited to such Examples. For example, it is possible to increase or decrease the width A of strip pieces S at will. It is provided, however, that if the width A of strip pieces S is larger than necessary, an error from a target design of belt layer tends to be larger. On the other hand, if an attempt is made to form the belt layer as in accord with a target design, it is required to reduce the width A of strip pieces S, resulting in an increase in the required number of strip pieces and a lowering of the productivity. Thus, preferably the width A of strip pieces is not smaller than 5 mm but not larger than 100 mm.

[Brief Description of the Drawings]

[0043]

[Fig. 1] A meridian-sectional view of a pneumatic tire, representing an example of pneumatic tires obtainable by the method of manufacture of tires according to the present invention.

[Fig. 2] A plan view, showing belt layers extracted from the pneumatic tire of Fig.

1.

[Fig.3] A sectional view showing belt layers extracted from the pneumatic tire of Fig. 1.

[Fig. 4] A view taken for illustration of designing of belt layers in or of the pneumatic tire of Fig. 1.

[Fig. 5] A view taken for illustration of strip pieces on a forming drum in a first method of production of a pneumatic tire according to the present invention.

[Fig. 6] A view showing a dimensional specification of strip pieces in the first method of production of a pneumatic tire according to the present invention.

[Fig. 7] A view taken for illustration of strip pieces on a forming drum in a second method of production of a pneumatic tire according to the present invention.

[Fig. 8] A view showing a dimensional specification of strip pieces in the second method of production of a pneumatic tire according to the present invention.

[Fig. 9] A view taken for illustration of strip pieces on a forming drum in a third method of manufacture of a pneumatic tire according to the present invention.

[Fig. 10] A view showing a dimensional specification of strip pieces in the third method of manufacture of a pneumatic tire according to the present invention.

[Fig. 11] A view taken for illustration of strip pieces on a forming drum in a fourth method of manufacture of a pneumatic tire according to the present invention.

[Fig. 12] A view showing a dimensional specification of strip pieces in the fourth method of method of a pneumatic tire according to the present invention.

[Explanation of Reference Signs]

[0044]

1: tread part;

2: sidewall;

3: bead portion;

4: carcass layer;

5: bead core:

B: belt layer(s);

B_1: inner belt layer;

B_2: outer belt layer;

L: circumferential length of belt layer;

L_1: circumferential length of inner belt layer;

L_2: circumferential length of outer belt layer;

C: steel cord;

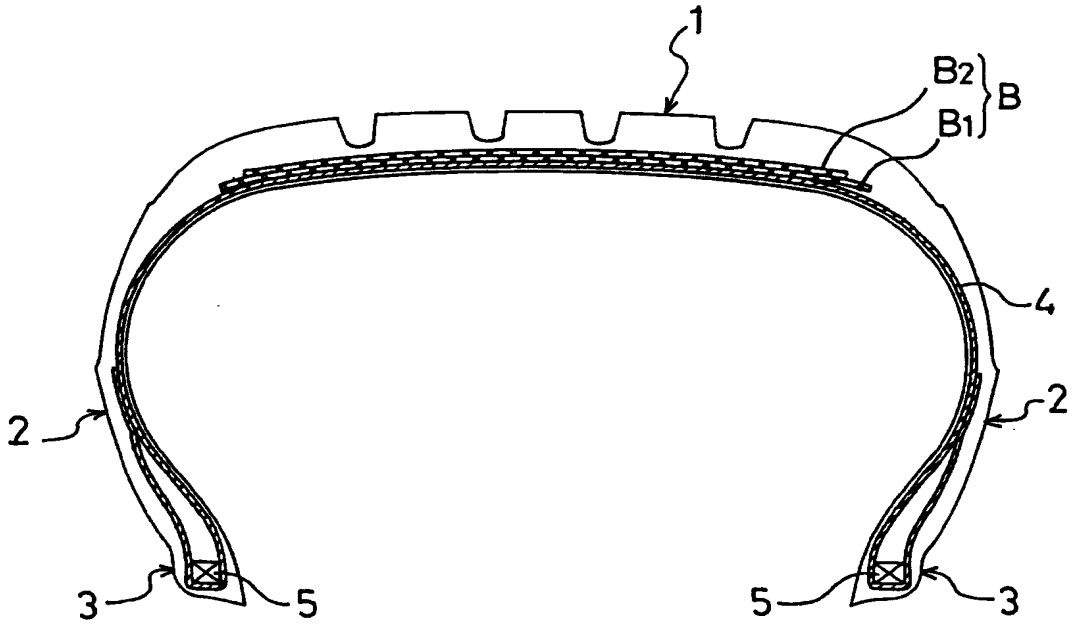
S: strip piece(s);

A: width of strip pieces;

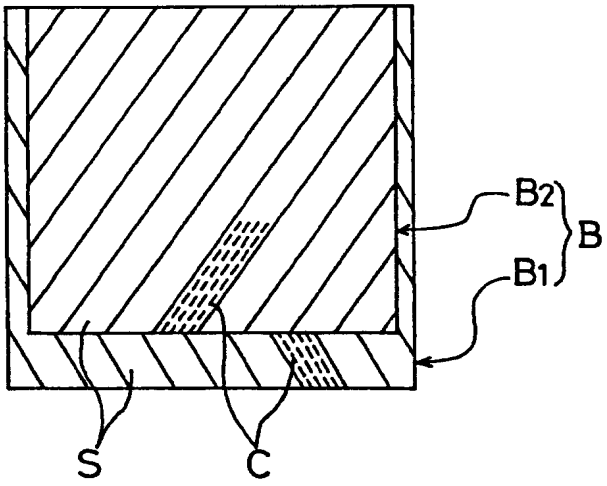
a: width of strip pieces in circumferential direction ($\sin \theta = A/a$); and

θ : belt angle (cord angle)

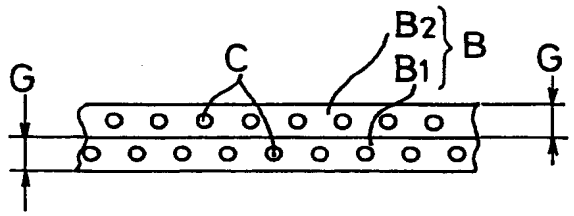
[Document] [Drawings]
[Fig. 1]



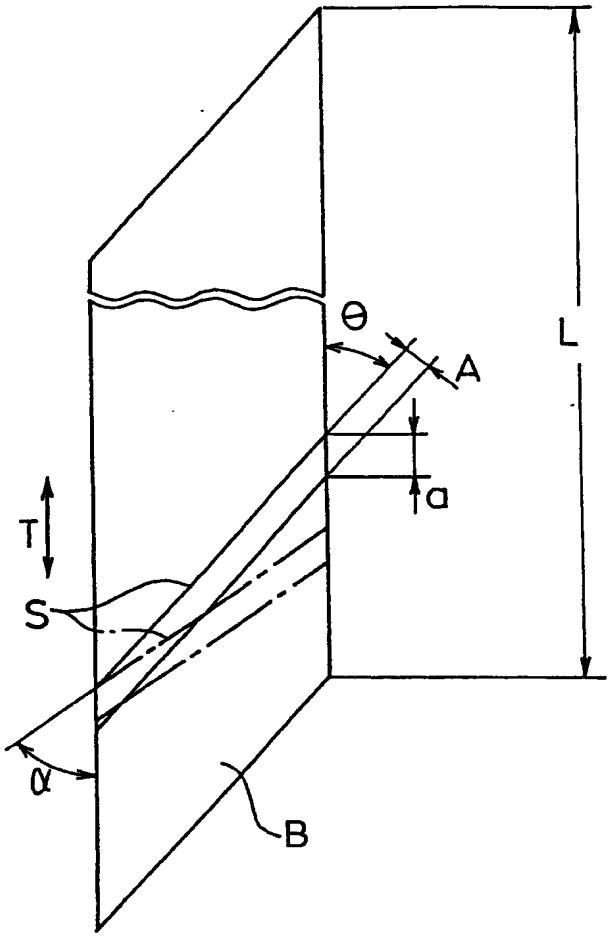
[Fig. 2]



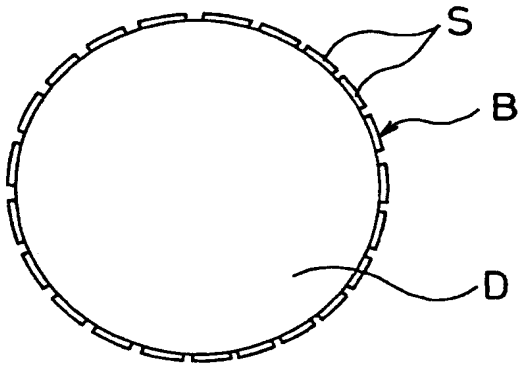
[Fig. 3]



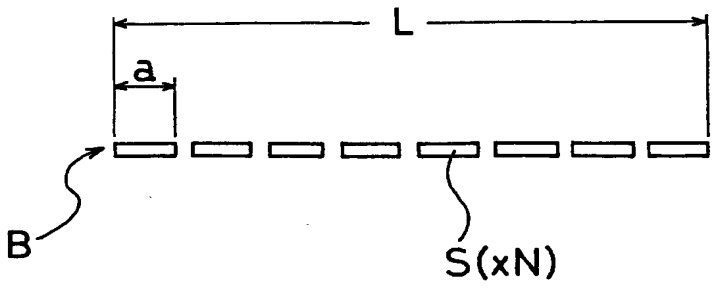
[Fig. 4]



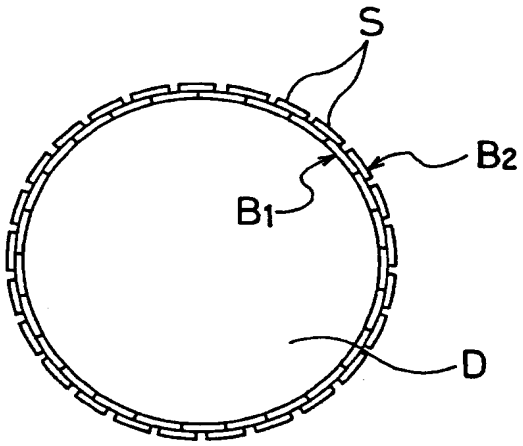
[Fig. 5]



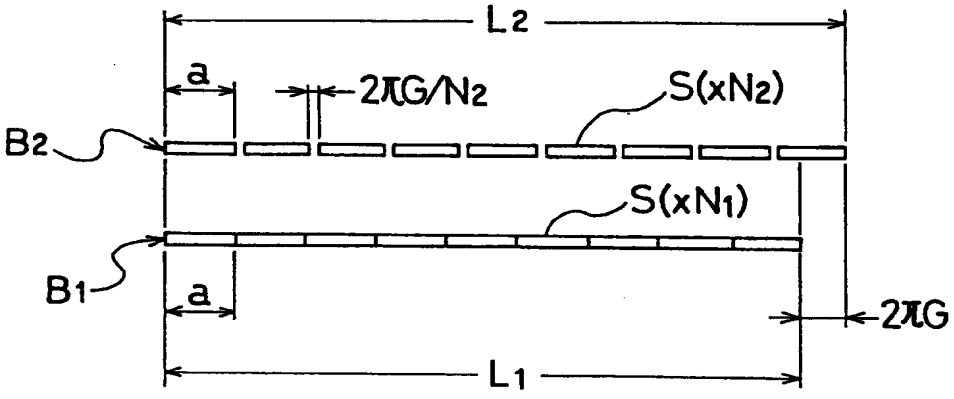
[Fig. 6]



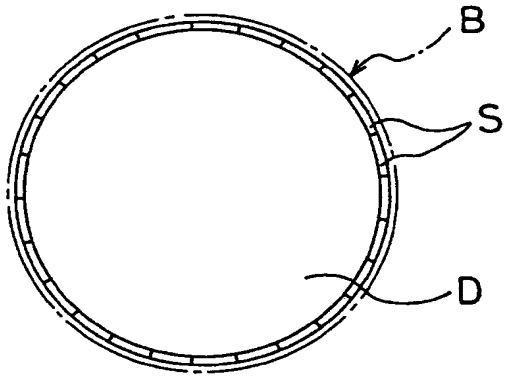
[Fig. 7]



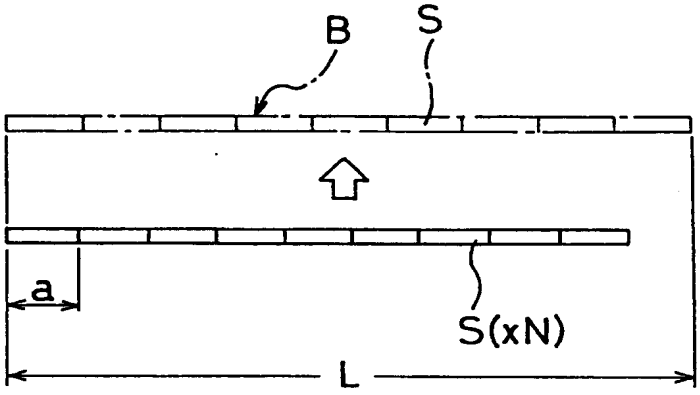
[Fig. 8]



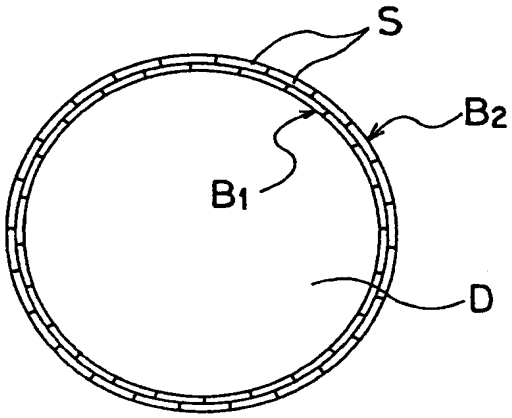
[Fig. 9]



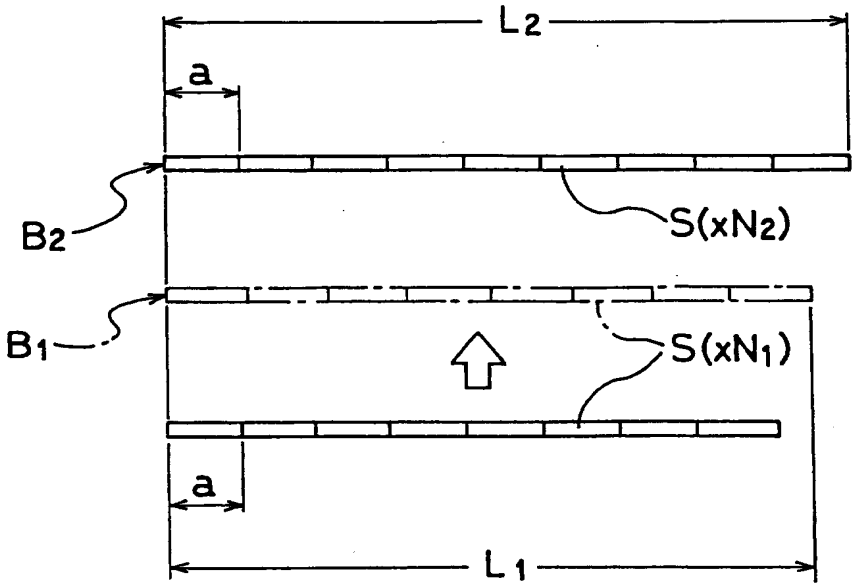
[Fig. 10]



[Fig. 11]



[Fig. 12]



[Document] ABSTRACT

[Abstract]

[Subject] To provide a pneumatic tire in which a belt layer is formed with use of an integer number of strip pieces without mutual overlapping of strip pieces, and a method of manufacture thereof.

[Means for Attainment] In a method of manufacturing a pneumatic tire provided with a belt layer B composed of a plurality of strip pieces S each comprising a plurality of steel cords C altogether withdrawn and rubberized, the belt layer B is formed by arranging a number N of strip pieces equidistantly interspaced in a circumferential direction of the tire on a forming drum, wherein for the number N an integer satisfying $(N + 1) \times A/\sin\theta > L > N \times A/\sin\theta$ is selectively used, assuming that the width of strip pieces is A, the number of strip pieces S being N, the cord angle of the belt layer B relative to the circumferential direction of the tire being θ, and the circumferential length of the belt layer being L.

[Elected Drawing Figure] Fig. 2